Designing of Offshore DNV Container

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***Abstract*—DNV standards are available for designing of Shipping Containers. These standards assures safe working requirements thru correct method of design, manufacture, testing, certification, marking and periodic inspection. A Offshore Container is designed, built and Tested according to DNV 2.7.1, which is used to hold a Compressor Unit in it. A Engine driven screw Compressor is given a outer shape of a Container, which has advantage of less space, ease of handling.**

***Index Terms*— DNV 2.7.1 (DET NORSKE VERITAS) Standard for Certification of Offshore Containers, Design of DNV container, Container Calculations, Offshore container requirements, Lifting test, Vertical Impact Test.**

I. INTRODUCTION

Compressor is used for various applications in industry, such as cleaning, sand blasting, painting etc. European regulations specifies limit on the operational sound level of the compressor. Different types of Canopies are designed to limit the noise. Ducting, doors, louvers are provided on canopy to maintain the cooling air flow in the compressor unit and to limit the noise level. Many times the compressor units are supported with external frames to have better strength in transportation. Recent research shows optimizing techniques for the air flow and minimizing the noise level in the canopy by using advanced techniques like CFD analysis. [4][5][6]

Increasing the size of canopy is a basic answer to over come less air flow and operational noise problems of the compressor. The canopy design becomes easy and more useful when it is integrated in a container. The containerized canopy has following advantages –

- Easy transportation of the container unit.
- Better strength in canopy closure.
- No exterior supporting frames required for transportation.
- More internal Space.

Standard containers are available in market which has a fixed size and load carrying capacity. However one can design customized container according to DNV standards. A customized 15 feet container is developed to hold a Compressor Unit inside it. This paper gives insight of the methodology of the Container designing and testing which enable for the DNV certification. [1]

A. DNV standard for certification

The DNV 2.7.1 standard specifies the requirements of Design, Manufacturing, Testing, certification, marking and periodic inspection. The requirements in this Standard for Certification are based on a number of assumptions stated in standard regarding the handling and operation of offshore containers. The Standard for Certification covers the container structure and any permanent equipment for handling, filling, emptying, refrigerating, and heating and safety purposes

The intention is that offshore containers shall meet the following requirements to be safe in use with regard to:

- lives
- Environment
- Hazard to the vessel/installation
- Be suitable for repeated use through choice of:
- Material
- Protection
- Ease of repair and maintenance.

B. Definitions and terminologies in container designing

The general terminology of the Shipping Container is explained in the Fig 1.

Primary Structure:

Load carrying and supporting frames and load carrying panels. Primary structure includes the structural components such as Load carrying and supporting frame, Load carrying panels (floor, 'tween decks), Fork lift pockets, Pad eyes, Supporting structures for tank, Supports for heavy equipment, Corner/knee brackets.

Secondary Structure:

These are the parts that are not considered as load carrying for the purposes of the design calculations. Secondary structure includes the components such as Doors, wall and roof panels, covers on skids, Panel stiffeners and corrugations, Structural components used for tank protection only, Internal securing points. To do the Certification of the Designed containers following documentation is required –

i) Design review
ii) Inspection and Testing Prototype.
iii) Production inspection and Testing.

II. DESIGNING OF CONTAINER STRUCTURE

The designing of the Container includes designing of Primary and secondary structure and other minor details.

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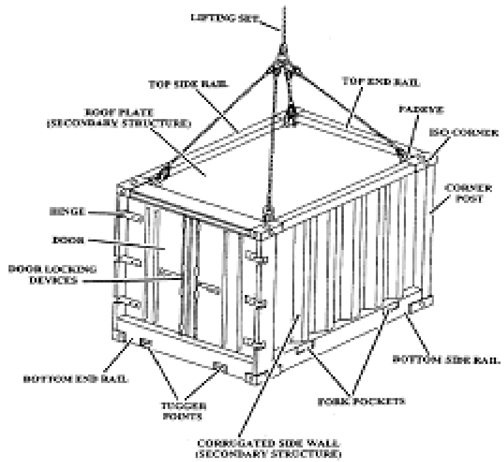

Fig 1 Shipping Container Terminology.

For designing structural elements the Load is calculated by following method.

A. Lifting load :

The lifting load on primary structure is taken as below,

FL = 2.5 x R x g (1)

= 2.5 x 6400 x 9.81 = 156.9 kN

Where FL is Force Lifting, R is Rating Mass and g is acceleration due to gravity.

The eye pads are designed as follows,

FP=3 × R × g (2)

= 3 x 6400 x 9.81 = 188.3 kN

Where FP is Force on eye pads.

And the load considered for fork lift pockets is

FF =1.6 x (T+S) x g (3)

= 1.6 x (1600 + 50) x 9.81 = 26 kN

Where FF is Force Forklift, T is Tare mass, S is Weight of Lifting set.

The Forklift pockets are designed for lifting empty container only.

B. Impact Loading:

The main frame structure shall be dimensioned to withstand a local horizontal impact force acting at any point. This force may act in any horizontal direction on the corner post.

FHICP=0.25 × R × g (4)

= 0.25 x 6400 x 9.81 = 15.6 kN

Where FHICP is Force horizontal Impact corner post

And horizontal force on frame members of the side structure, including the top rails is calculated as below,

FHISS = 0.15 × R × g (5)

=0.15 x 6400 x 9.81 = 9.4 kN

Where FHISS is the horizontal Impact load on Side Structure.

Maximum vertical impact forces are likely to occur when a container is lowered down to a heaving ship deck. If the deck is at an angle, the first impact will be on a corner.

FVI = 0.25 × R × g (6)

= 0.25 x 6400 x 9.81 = 15.6 kN

Where FVI is Force vertical impact.

The container structure is designed by selecting structural members in the Conventional design method, to sustain above load. The 3D modeling is done in available CAD software. (Pro E)

C. FEA Analysis of the Container :

Designing for the DNV shipping container can adapt Finite element analysis method for better calculations. The above calculated values are also used as a Input for the FEA of the Container. The uniform loading is considered for FEA. For Strength calculation only primary structural members are considered. Figure 2 shows schematic of loading method adapted in FEA The material selected is a Hot Rolled Steel. The FEA analysis is performed by using 4g loading. Force applied on the container floor in downward direction and support is given at lifting hook location.

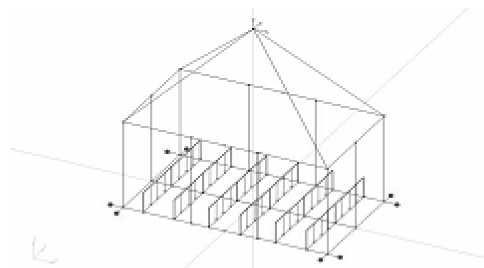

Fig 2 : FEA loading Conditions.

III. MANUFACTURING

THE CONTAINer is manufactured by a ISO certified fabrication vendor. Non Destructive Examinations are done for checking the weld quality.

IV. PROTOTYPE TESTING

A. PREPARATIOn and Calibration:

The tare mass (excluding lifting set) was verified by weighing before tests performed. If the tare mass deviates from the estimated value, the payload shall be adjusted accordingly. The test masses were evenly distributed inside the prototype. The sand bags are used as a test mass and are verified using calibrated weights. This calibration is done according to EN ISO 7500-1. The accuracy achieved is +/- 2%.

B. Lifting test:

The prototype was loaded up to a total gross mass of 16000KG. This is 2.5 times the rated mass. This lifting test is carried in such a way that no significant acceleration occurs. After lifting the Container is hold at lifted position for 5 minutes before the measurements are taken. The designed container has length of 4572mm. According to DNV the maximum deflection should not exceed 1/300 part of total span. This is 15.24mm. No deflections during testing observed greater than 1/300 of the span of the member. The container has not shown the significant permanent deformations or other damages after testing.

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C. Vertical Impact test:

The vertical impact test is carried out with its internal test mass corresponding to payload P. The container was dropped on to the concrete workshop floor. Quick disconnecting hook arrangement was used for dropping down the container. The offshore container was held inclined that each of the bottom side and end girders connected to the lowest corner forms an angle of not less than 5° with the floor. The container was dropped down on floor from the lowest height difference of 5 cm from floor. See fig 3 for the Drop test details.No plastic deformation or cracks observed after the after the drop test. This fulfils the strength requirement according to the DNV standards.

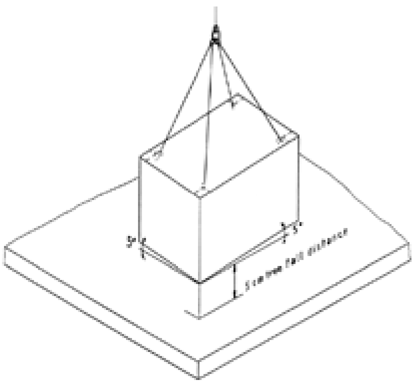

Fig. 3 Drop Test Container.

V. DESIGN OF CANOPY FOR THE COMPRESSOR UNIT.

The Container manufactured was intended to use as a outer body for the Compressor Unit. The cooling air flow for the compressor and external connections, serviceability of internal parts was key parameters for deciding the Doors and openings on the container. All doors designed are according to requirements of ISO containers. The air inlet louvers are designed on the container doors which allows air intake for the compressor cooling and for the exhaust of the hot air.

Fig. 4 shows the designed air flow in the container. The Air is taken in from longitudinal doors and exhausted from the short end doors. Two pusher fans of equal capacity are used in opposite directions.

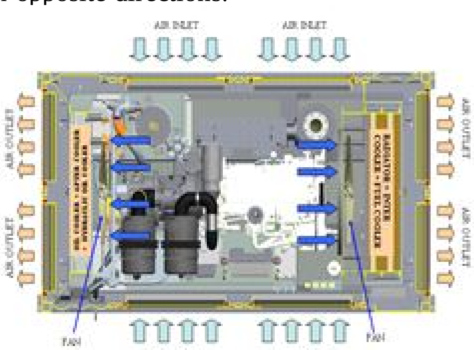

Fig. 4 Air flow thru container.

Fig 5 shows the actual photo of the container manufactured.

Fig. 5 Container Outer look

V. CONCLUSION

Shipping containers are available in Standard sizes. A non standard size container is designed, manufactured and tested. The designed container fulfils all the requirements of the DNV 2.7.1 certification, and can be used for offshore application. A compressor product is integrated inside the container. Use of Container as an outer body of Compressor unit serves means of weather protection, sound damping and ease and safe handling of compressor unit.

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